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AIP

The unevenly distributed nearest brown dwarfs

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To address the questions of how many brown dwarfs there are in the Milky Way, how do these objects relate to star formation, and whether the brown dwarf formation rate was different in the past, the star-to-brown dwarf number ratio can be considered. While main sequence stars are well known components of the solar neighborhood, lower mass, substellar objects increasingly add to the census of the nearest objects. The sky projection of the known objects at <6.5 pc shows that stars present a uniform distribution and brown dwarfs a non-uniform distribution, with about four times more brown dwarfs behind than ahead of the Sun relative to the direction of rotation of the Galaxy. Assuming that substellar objects would distribute uniformly, their observed configuration has a probability of 0.1 %. The helio- and geocentricity of the configuration suggests that it probably results from an observational bias, which if compensated for by future discoveries, would bring the star-to-brown dwarf ratio in agreement with the average ratio found in star forming regions.

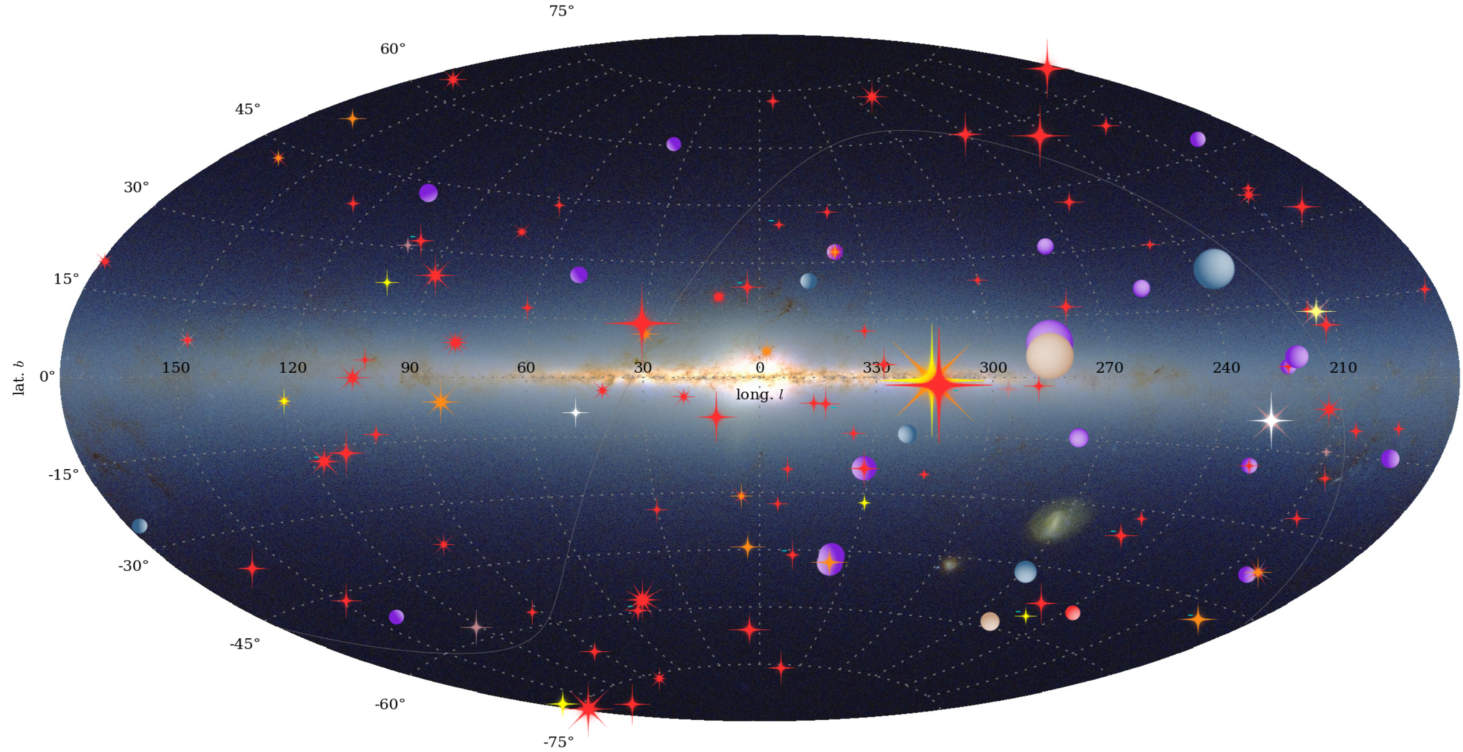

Fig. 1: Distribution of the known d < 6.5 pc stars (*stars*) and brown dwarfs (*spheres*) over the 2MASS near-infrared sky (Aitoff projection, galactic coordinates). Their masses are of 2.0-0.075 and ~0.075-0.007 Msol. Symbol size is proportional to parallax; the nearest known stellar- (Alpha Centauri ABC) and substellar (Luhman AB) systems are at 1.3 and 2.0 pc, respectively. Brown dwarfs are illuminated by a virtual source 25 pc ahead of the Sun and from the direction of rotation of the Galaxy (l = 90°). Their MLTY types are in red, light brown, violet, and blue colors, and the stellar AFGKMD types in effective-temperature related visible colors (white, white-yellow, yellow, orange, red, and pink), respectively. Dashed stars indicate known exoplanets. The Earth equator projected on the sky is shown by the gray curve.

More brown dwarfs expected

Solar neighborhood censuses have found star-to-brown dwarf ratios of 10 (RECONS 2016; trigonometric parallax errors <10 mas) and 6 (WISE; Kirkpatrick et al. 2012, ApJ, 753, 156; Schneider et al. 2016, ApJ, 817, 112), higher than found in star forming regions, and suggesting some paucity of old (~1-10 Gyr) brown dwarfs. The updated list of 136 stellar- and 26 substellar objects at d < 6.5 pc indicates however that most of the latter (81%) are located behind the Sun relative to the rotation of the Galaxy, while there are 70/65 stars (or 45/52 stellar systems) ahead/behind the Sun (Fig. 1). This remarkably uneven configuration of brown dwarfs has a probability of 0.1%, assuming these would distribute uniformly. Also, these are represented by four spectral types and five multiplicity modes at l = 180-360 deg, whereas by only two types and one mode at l = 0-180 deg. 5-16 more brown dwarfs filling the gap would shift the ratio to 3.2-4.4.

Stars and brown dwarfs in the Milky Way

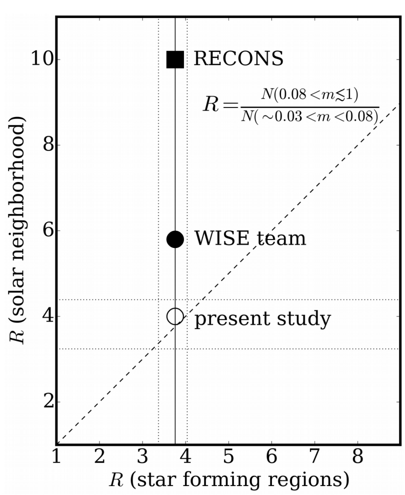

Fig. 2: Stars-to-brown dwarf ratios for different regions of the Milky Way. The estimates for the solar neighborhood are compared with the average estimate for star forming regions of 1-120 Myr (Parravano et al. 2011, ApJ, 726, 27; McKee et al. 2015, ApJ, 814, 13); the expected ratio reaches agreement, corroborating four stars for every brown dwarf.

Further details in:
Bihain & Scholz, A&A, 2016, 589, A26